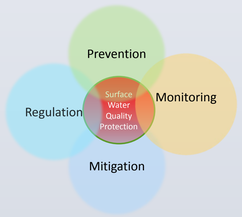
Protecting Surface Water from Pesticide Contamination in California

K S Goh, N Singhasemanon, Y Luo, M Ensminger, R Budd, X Zhang, X Deng, S People,
K Kelley, K Newhart, A DaSilva, Y Xie, J Teerlink, A Aldana, K D King, K Moss, D Duncan
Surface Water Protection Program, Department of Pesticide Regulation, California Environmental Protection Agency

ABSTRACT

The mission of the California Department of Pesticide Regulation's Surface Water Protection Program (SWPP) is to protect surface water from pesticide contamination caused by the use of pesticides in agricultural and urban environments. The program relies on both preventive and response components to prevent adverse impacts of pesticide residues to humans and aquatic organisms. To achieve its mission, the program integrates the following key components: a) the evaluation of pesticide products submitted for registration in California, b) the monitoring of surface water and sediment for high use pesticides with high aquatic toxicity potential, c) the modeling of fate & transport of pesticides to predict environmental concentrations and assess environmental risks, d) the evaluation of the effectiveness of best management practices to mitigate the offsite movement of pesticides, e) the outreach to pesticide users to implement best management practices, and f) the implementation of regulatory measures. To implement the program mission, our scientists and analytical chemists work collaboratively with pesticide registrants, county agricultural commissioners, water boards and agencies, pesticide users, and university researchers (Table. 1).

REGULATORY AUTHORITY



The SWPP works under the authority of the Calif. Food and Agriculture Code specifically: [1] Section 11501(b). To protect the environment from environmentally harmful pesticides by prohibiting, regulating, or ensuring proper stewardship of those pesticides. [2] Section 14102.… prohibit or regulate the use of environmentally harmful materials,... consider the effect of all such materials upon the environment, and shall take whatever steps…to protect the environment. [3] Section 14103. …establishing criteria and regulations relating to environmental injury and protection. [4] Section 12824. …develop an orderly program for the continuous evaluation of all pesticides actually registered.

Table 1. Major components of the Surface Water Protection Program to protect surface water quality from pesticide contamination in California.

Component	Objective	Method	Development Plan
Prevention	Evaluate pesticide products for potential impact on surface water quality specific to California	Models: Methodology for Evaluating Pesticides for Surface Water Protection	• Model to evaluate degradates • Model for California specific conditions • QSAR
Monitoring	• Sample surface water and sediment in agriculture and urban areas for pesticide residues and determine toxicity and risk to aquatic organisms • Assess long-term trends and success of regulations • Assess effectiveness of mitigation measures	• Model: Methodology for prioritizing pesticides for surface water monitoring • Database: Surface water database for pesticide detected in California • Aquatic life benchmark comparison	Develop • Electronic data collection and reporting • Long-term monitoring network • Long-term passive samplers and equipment • Analytical method improvement and development • Statistical data analysis • Long-term in-situ toxicity testing and ecological assessment • GIS mapping and geo-spatial analysis • Biomarkers and molecular technology
Mitigation	Prevent further contamination of surface water and adverse impact to aquatic organisms.	• Evaluate effectiveness of mitigation measures • Conduct education and outreach to prevent surface water runoff • Encourage product stewardship	• Develop novel mitigation measures • Develop models to predict effectiveness of mitigation
Regulation	Use regulatory authority to mitigate contamination of surface water and reduce impact on aquatic organisms	• Re-evaluation of problem pesticides • Label changes on pesticide use • Issue permit conditions • Promulgate regulations	• Design study, apply statistical analysis and model to assess and predict effectiveness of regulation

Figure 1. Sampling sediment in agricultural areas at Salinas River, Monterey County, Calif.

PREVENTION

This pesticide runoff prevention step in evaluating pesticide products submitted to California for registration is evaluated in two-stages: [1] initial screening, and [2] refined modeling (Luo & Deng 2012; Fig. 2) with urban scenarios (Luo 2014). Initial screening is based on chemical properties (soil adsorption coefficient, water solubility, and reaction half-lives) and aquatic toxicity data of the active ingredient. It quickly separates pesticides that are unlikely to be a surface water quality problem from one that may cause harm and require additional evaluation. Risk is further characterized on the product-specific information (use pattern and application rate) and the model provides final registration recommendations: [1] to support registration without conditions, [2] to support conditional registration with requests for analytical methods and place the active ingredient on watch-list, or [3] do not support registration. The watch-list covers active ingredients with potential exposure to surface water. Potential actions for the listed pesticides include: require analytical method for post-use monitoring, flagging for re-assessment if its new label is associated with high-exposure use pattern, and post-use monitoring for surface water quality.

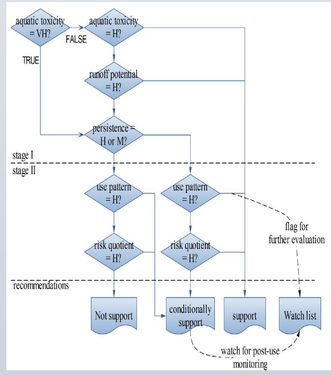


Figure 2. Pesticide registration review model to protect surface water quality. VH=very high, H=high, M=medium (from Luo and Deng 2012).

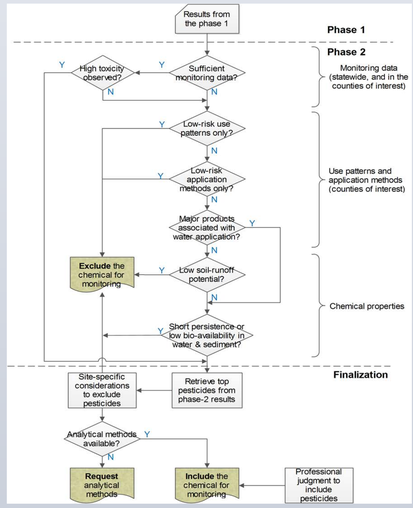


Figure 3. Scheme to prioritize pesticides for monitoring in surface water (from Luo et al., 2014)

MONITORING

Pesticides are prioritized for surface water monitoring in agricultural and urban areas (Luo et al., 2014; Fig.1,3): Phase 1 generates preliminary priority lists of pesticide active ingredients, based on pesticide use data and aquatic life and drinking water benchmarks (USEPA 2014). Phase 2 identifies pesticides with relatively high risks to surface water quality by systematic evaluation based on historical monitoring results, use patterns, application methods, physicochemical properties, and degradate data to generate monitoring recommendations for [1] monitoring (if the pesticide may potentially cause surface water toxicity and the analytical method is available), [2] requesting analytical methods (if analytical method is not available), or [3] not monitoring (if the pesticide is unlikely to cause surface water toxicity) in the user-defined domain of counties and months. All analytical method development and sample analyses are conducted at the California Department of Food and Agriculture's Center for Analytical Chemistry. Monitoring data are uploaded to our surface water database and analyzed for trends of pesticide concentrations and effectiveness of mitigation measures and regulations.

Figure 4. Constructed wetland to mitigate pesticide runoff, Patterson, Calif.

MITIGATION

Pesticides detected in high frequency and at concentration exceeding US EPA aquatic life benchmarks are targeted for mitigation actions (US EPA 2014). We will be initiating collaborative educational and outreach program to pesticide users in taking measures to mitigate pesticide runoff. Discussion will be initiated specifically with the pesticide registrants and professional user groups to take voluntary product stewardship measures and when necessary follow-up with formal re-evaluation process. Re-evaluation entails requesting registrants to further identify the sources (use patterns and use sites) and the processes of a pesticide contributing to surface water contamination, and to conduct study to evaluate and implement various mitigation measures to reduce pesticide runoff (Fig. 4). Mitigation could be in the form of issuing permit conditions with use restrictions; product label changes by registrant; or regulations with restrictions including limitation on application methods, timing of application, target sites, environmental conditions, formulation, buffer zone to sensitive sites, etc.

REGULATION

We have implemented re-evaluations for diazinon, chlorpyrifos, copper anti-fouling paints, and pyrethroids (DPR 2014b) resulting in two regulations: 2006 on dormant spray for diazinon and chlorpyrifos, and 2012 urban surface water protection regulations for pyrethroids. [1] Dormant spray regulation allows only application to hydrologically isolated sites or farms with water recirculating systems or holding ponds (72 h hold) otherwise a written recommendation from a licensed pest control advisor is needed with a buffer zone (100 ft) to sensitive sites and with wind speed limitations (3-10 mph). [2] Urban surface water protection regulation for pyrethroids limits application methods, and limits or prohibits application to certain sites and conditions with high runoff potential (DPR 2014b).

REFERENCES

DPR 2014a. Product Registration Review Process. http://www.cdpr.ca.gov/docs/emon/surfwtr/review.htm

DPR 2014b. Surface Water Regulatory Issues. http://www.cdpr.ca.gov/docs/emon/surfwtr/reg_index.htm

Luo Y and X Deng. 2012. Methodology for Evaluating Pesticides for Surface Water Protection I. Initial Screening; II. Refined Modeling. http://www.cdpr.ca.gov/docs/emon/surfwtr/review.htm

Luo Y. 2014. III: Methodology for Evaluating Pesticides for Surface Water Protection Module for Urban Scenarios. http://www.cdpr.ca.gov/docs/emon/surfwtr/review/report3.pdf

Luo Y, Ensminger M, Budd R, Deng X, and DaSilva A. 2014. Methodology for Prioritizing Pesticides for Surface Water Monitoring in Agricultural and Urban Areas II: Refined Priority List. http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/prioritization_report_2.pdf

US EPA 2014. Office of Pesticide Programs' Aquatic Life Benchmarks http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm